US010641931B2

(12) **United States Patent**
Tada et al.

(10) **Patent No.: US 10,641,931 B2**
(45) **Date of Patent: May 5, 2020**

(54) **FRESNEL LENS AND MANUFACTURING METHOD FOR FRESNEL LENS**

(71) Applicant: **Sony Interactive Entertainment Inc.**, Tokyo (JP)

(72) Inventors: **Shotaro Tada**, Aichi (JP); **Manabu Ishioka**, Tokyo (JP); **Toshihiro Kusunoki**, Tokyo (JP)

(73) Assignee: **Sony Interactive Entertainment Inc.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 45 days.

(21) Appl. No.: **16/061,792**

(22) PCT Filed: **Feb. 6, 2017**

(86) PCT No.: **PCT/JP2017/004169**
§ 371 (c)(1),
(2) Date: **Jun. 13, 2018**

(87) PCT Pub. No.: **WO2017/138480**
PCT Pub. Date: **Aug. 17, 2017**

(65) **Prior Publication Data**

US 2018/0372925 A1 Dec. 27, 2018

(30) **Foreign Application Priority Data**

Feb. 9, 2016 (JP) 2016-023151

(51) **Int. Cl.**
G02B 3/08 (2006.01)
G02B 3/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***G02B 3/08*** (2013.01); ***C23C 14/04*** (2013.01); ***C23C 14/5873*** (2013.01); ***F21V 5/045*** (2013.01); ***G02B 3/00*** (2013.01)

(58) **Field of Classification Search**
CPC . G02B 3/08; G02B 1/041; Y02E 10/52; F24S 23/31; H01L 31/0543
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,676,804 A * 10/1997 Fujii C23C 14/04 204/192.14
8,649,095 B2 2/2014 Ando
(Continued)

FOREIGN PATENT DOCUMENTS

JP 06250003 A 9/1994
JP 07306307 A 11/1995
(Continued)

OTHER PUBLICATIONS

Extended Search Report for corresponding EP Application No. 17750203.6, 9 pages, dated Aug. 20, 2019.
(Continued)

Primary Examiner — Mohammed A Hasan
(74) *Attorney, Agent, or Firm* — Matthew B. Dernier, Esq.

(57) **ABSTRACT**

There are provided a Fresnel lens and a method of manufacturing the Fresnel lens which can suppress a flare which is generated in an image visually recognized through the Fresnel lens so as to extend toward a center of a lens. A lens surface and a non-lens surface are formed in each of lens portions. The non-lens surface includes a rise surface and a coupling surface. The rise surface is a surface along an optical axis of a Fresnel lens. The coupling surface is a surface which is formed on a top portion of each of the lens portions and couples the lens surface of the lens portion and the rise surface of the lens portion to each other, and which has a width extending in a radial direction of the Fresnel lens. A light absorbing portion is provided in a position
(Continued)